INVENTION REPORT # ______ D474

Attachment (6)

SUBMITTED BY [redacted] DATE Aug 15, 60 STAT

DESCRIPTIVE TITLE A FIXED GRID DEVICE FOR PASSIVELY SENSING THE RATIO VELOCITY / ALTITUDE

Briefly, What Problem Were You Working On?

Detection of V/H (velocity/altitude) for image motion compensation in aerial cameras. The original concept was developed while working on a proposal for a High Acuity Camera but subsequent work was done under contract.

How Does the Invention Work in Solving This Problem?

Light from the ground is imaged onto a fixed grid of alternating transparent and opaque lines. Light passing through is collected in a photocell and converted to an electrical signal. This electrical signal has a predominant oscillitory component, the frequency of which is proportional to V/H.

Circumstances Surrounding the Invention. (Notebooks for reference, other people contributing?)

Report #5200 by [redacted] (proposal to study and build moving grid V/H sensor) STAT

Report #5455 and Addenda (proposal for High Acuity Camera with fixed grid V/H sensor as part of it)

Report 5419 A – similar to 5455

Notebook 980 pp 1-4 (June 5 '59)

Notebook 1106 pp 97-107, 120-121

RECEIVED AUG 16 1960 PATENT DEPT. THE PERKIN-ELMER CORP.

Experimental work and some study done under SPO 71695 later 71945. Other contributers: [redacted] and probably others STAT

ON OPTIMUM DESIGNS FOR FIXED-GRID V/H SENSORS

Introduction

With modern reconnaissance systems there is a very urgent need for a simple automatic, passive device which will measure the ratio

$$\frac{V}{H} = \frac{\text{Vehicle velocity with respect to ground}}{\text{Vehicle altitude above ground}} \qquad (1$$

At the present time there are three basic ways of determining this ratio:

1) By tracking individual objects and measuring its apparent angular velocity.

2) By measuring the cross correlation between the light intensity received from two directions and computing V/H from the delay time between signals.

3) By measuring the frequency of signals generated by passing an optical image of the ground through a spatial filter which transmits only the desired image components.

The first method - although it is the one usually used by human beings - requires a great degree of sophistication and complexity for mechanized systems and as a result has not yet received much use.

The second method is simple and easily mechanized but has the disadvantage that a high capacity delay device is needed. This device usually takes the form of a tape recorder and therefore has many of the problems associated with moving parts.

The third method is slightly more complex than the second, but can be built without moving parts, and can easily be designed for very high accuracy and very fast response time.

This report is concerned with the third type of system, and in particular with a system in which the spatial filter assumes the form of a grid fixed in the image plane of an optical ground viewing system.

Expressions are derived which show how the system response depends on various system parameters, and from these expressions one can choose the optimum parameters.

Basic Principle of Operation

Consider the system shown in Figure I consisting of a lens, a grid fixed in the image plane of the lens, and a photocell behind the grid. Let this system move with velocity V at a fixed altitude H above a point source of light located on the ground. As the system moves past the light, the image of the point will move across the grid. The effect of the grid is to periodically attenuate the light so that the electrical signal from the photocell is a periodically pulsed current. If the grid spacing is 2a and the lens focal length, F, then the frequency of the pulsed photocell current is

$$\frac{V}{H} \frac{F}{2a} \triangleq \text{frequency} . \qquad (2$$

Since V/H is proportional to this frequency, all that remains to be done is to measure this frequency. We propose to do this by counting the number of times the A C. component of the signal crosses zero. For a sine wave ~~in~~ input of frequency $\frac{V}{H} \frac{F}{2a}$ there are $\frac{V}{H} \frac{F}{a}$ zero crossings per second.

The fact that the ground appears as a distribution of light sources rather than as discrete point light sources does not alter the basic results described here. The analysis must be on a statistical basis, but has been done in notebook #1106 pp 97-107.

Experimental units have been built and tested successfully.

Fixed Grid V/H Sensor
Aug 15 1960
Copied from Report 5419 A

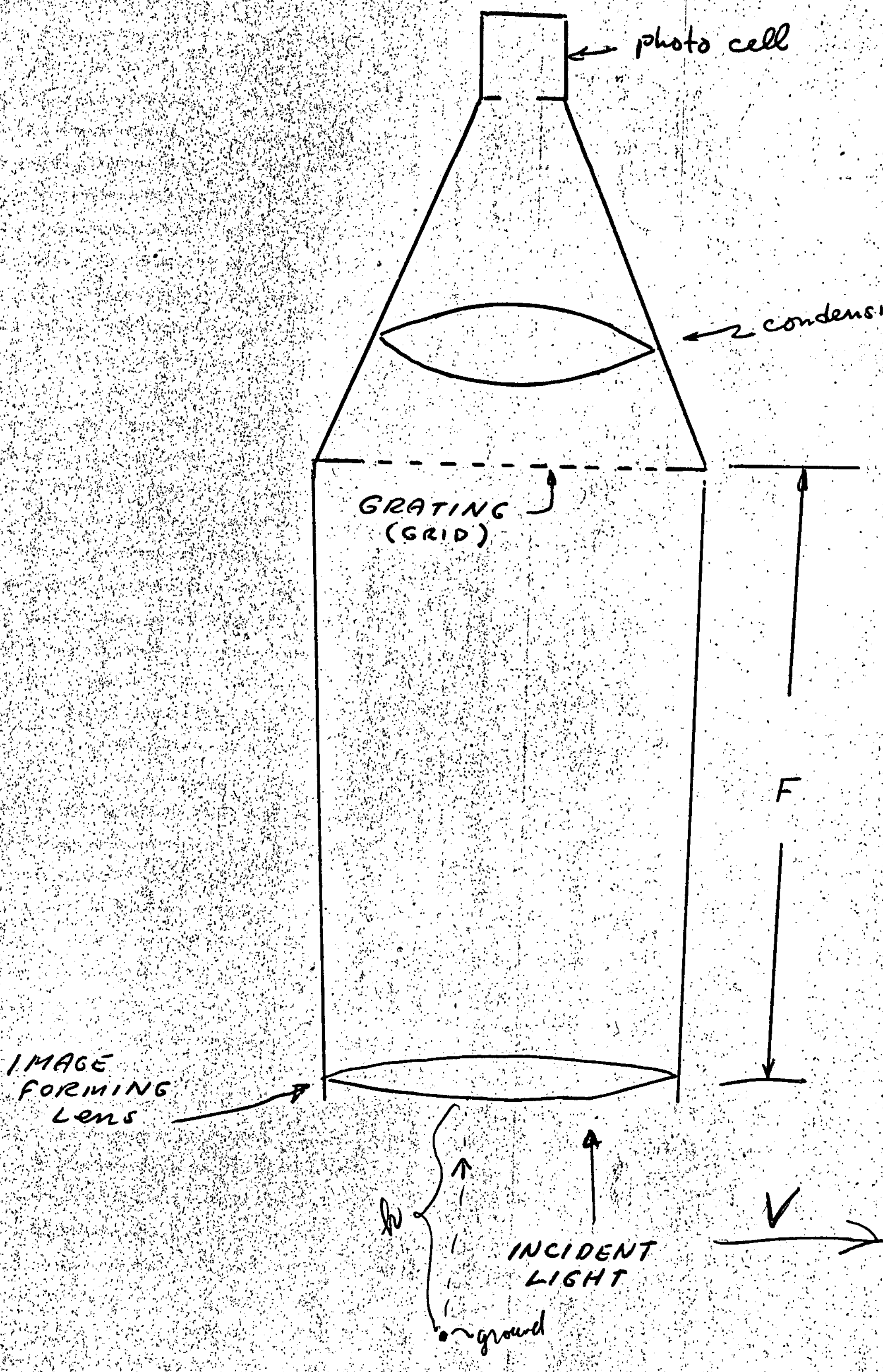

FIGURE 1
BASIC V/H Sensor with Fixed Grid